BIOASSESSMENT REPORT

A MEASUREMENT OF WATER QUALITY IN THE TWELVE MILE CREEK WATERSHED FOLLOWING WATERSHED LAND TREATMENTS

Prepared for the Cass County Soil and Water Conservation District

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EXECUTIVE SUMMARY

The Indiana Department of Natural Resources administers a conservation initiative known as the Lake and River Enhancement (LARE) program. Prior to implementation of various land treatments in the Twelve Mile Creek Watershed of Cass County, Indiana, the LARE program funded a biological assessment to determine the degree of biological impairment present in the stream. The benthic communities of five sites, including a previously established reference site, were sampled during October 1998 to provide information on "before treatment" conditions. Two of the five sites were slightly impaired. The biological communities of these sites were characteristic of excessive nutrient and sediment inputs.

Between 1998 and 2005, the Cass County SWCD allocated $260,000 to fund best management practices to address nonpoint source runoff problems in the watershed. Practices funded included grassed waterways, water and sediment control basins, tree planting, filter strips, hay and pasture planting, windbreaks, and manure management practices. The BMPs were paid for by LARE and related soil conservation programs.

In November 2005 and April 2006, the same five sites were re-examined using an identical biological assessment technique funded by LARE. The object of the study was to determine whether the best management practices resulted in improved water quality within the watershed. All four study sites had biotic index values similar to the reference site. The values have increased significantly since 1998, especially on Goose Creek, which had improvements in every biological metric during the autumn sampling season. New pollution-intolerant animals abundant at several sites in the watershed. Especially noticeable was an increase in the number of animals that do not tolerate sediment. These changes indicate that the agricultural best management practices initiated by the Cass County SWCD have been successful in improving water quality in Twelve Mile Creek.

INTRODUCTION

This study was conducted to measure the "biological integrity" of Twelve Mile Creek in Cass County, Indiana. This stream is a tributary of the Eel River, which is listed by the Indiana Department of Environmental Management (IDEM) as having seriously degraded water quality due to nonpoint sources of pollution [1]. In 1998, a biological study of the stream was conducted using methods recommended and funded by the Indiana Department of Natural Resources in their Lake and River Enhancement (LARE) program. The purpose of this study was to document conditions in the stream prior to implementation of agricultural "best management practices."

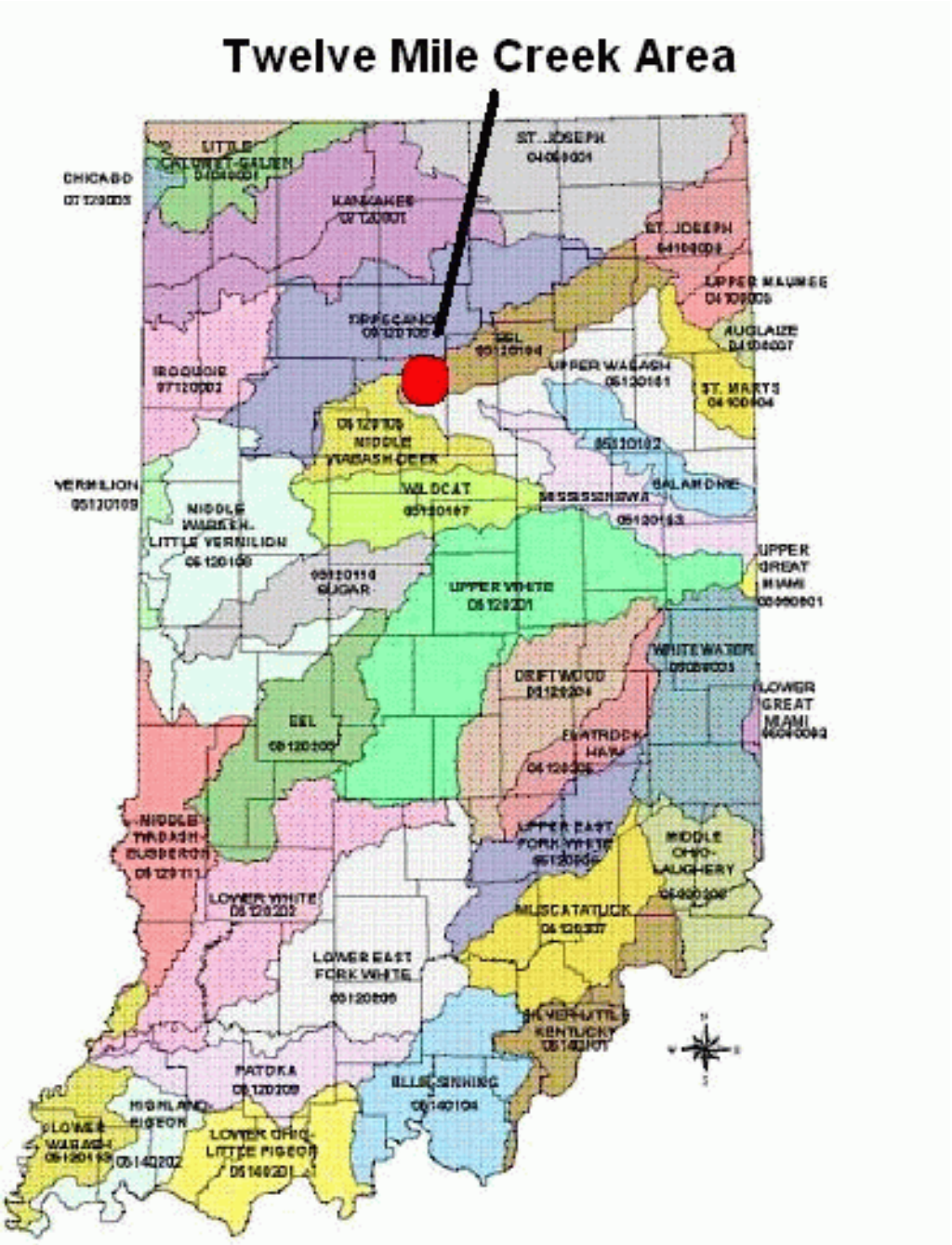
Soil conservation plans were implemented by the Cass County SWCD office to help reduce non-point source problems in the stream. Between 1998 and 2005, the Cass County SWCD allocated $260,000 to fund best management practices to address nonpoint source runoff problems in the watershed. Practices funded included grassed waterways, water and sediment control basins, tree planting, filter strips, hay and pasture planting, windbreaks, and manure management practices. A copy of all funded practices, paid by LARE and related soil conservation programs, is attached in the appendix.

The present study of Twelve Mile Creek was conducted to determine whether watershed land treatments implemented by the county resulted in improved water quality as reflected by improved aquatic biological communities. The methods used were identical to those in the 1998 study.

Local Setting

Twelve Mile Creek is located in the "Eastern Corn Belt Plain" ecoregion of the Central U.S. [2]. The area is a glacial till plain (it was one of the last areas in Indiana to be occupied by glacial ice) and lies in what is sometimes called the "Bluffton Till Plain" Natural Region of Indiana [14] This is an area with little geographic relief and whose soils are typically rich in clay. Much of the area is poorly drained. The original forests were dominated by beech and maple, but row crop agriculture and livestock grazing are the most common land uses today. In fact, about 97% of the Eel River watershed is devoted to agricultural uses and only about 1% is forested [19]. The location of the watershed area within Indiana is shown in Fig. 1.

Fig. 1. Location of Cass County and the local watersheds

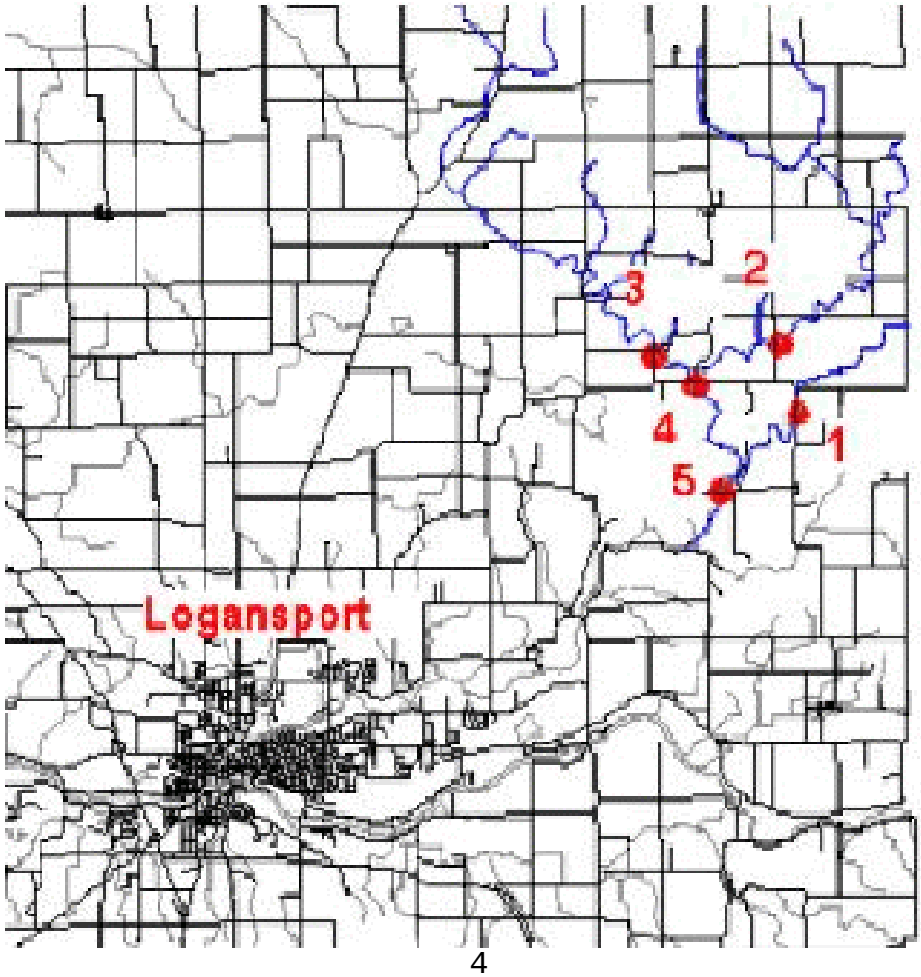


Twelve Mile Creek is a small "third order" stream with a total drainage area of 133 square kilometers or 52 square miles [18]. It flows southward and joins Eel River in central Cass County. Four "study" sites and a "reference" site were chosen for study (Fig. 2). The study sites represented the three major tributaries of Twelve Mile Creek as well as a reference site and a site on Lower Twelve Mile Creek. The reference site is described in more detail below. A summary of each site and its watershed area is shown below:

Site 1 Goose Creek @ CR 925 E	**10 km^2 (4 mi^2)**
Site 2 East Branch @ CR 900 E	**61 km^2 (24 mi^2)**
Site 3 West Branch @ CR 500 N	**49 km^2 (19 mi^2)**
Site 4 Twelve Mile Creek @ CR 450 N (Reference)	**15 km^2 (45 mi^2)**
Site 5 Twelve Mile Creek @ CR 300 N	**133 km^2 (52 mi^2)**

Benthic samples and water quality measurements reported here were collected on November 8, 2005 and April 28, 2006.

Figure 2.
Location of the study sites.



METHODS

Because they are considered to be more sensitive to local conditions and respond relatively rapidly to environmental change [3], benthic (bottom-dwelling) organisms were used to document the biological condition of each stream. The U.S. Environmental Protection Agency (EPA) has recently developed a "rapid bioassessment" protocol [4] which has been shown to produce highly reproducible results that accurately reflect changes in water quality. We used EPA's Protocol III to conduct this study. Protocol III requires a standardized collection technique, a standardized subsampling technique, and identification of at least 100 animals from each site to the genus or species level from both "study sites" and a "reference site." CPOM (Coarse Particulate Organic Matter) samples were collected and analyzed but contained very few shredder organisms, even at the reference site. Therefore, Ohio EPA's "% mayflies" metric [21] was substituted for % shredders. The metrics and scoring system are summarized in Table 1.

Table 1. Calculation of Biotic Index

	Points per metric				
	6	4	2	0	
Metrics					
# of Genera	>80	60-80	40-60	<40	*
Biotic Index	>85	70-85	50-70	<50	**
Scrapers/Filterers	>50	35-50	20-35	<20	*
EPT/Chironomids	>75	50-75	25-50	<25	*
% Dominant Taxon	<20	20-30	30-40	>40	
EPT Index	>90	80-90	70-80	<70	*
Community Loss Index	<0.5	0.1-1.5	1.5-4	>4	
% Mayflies	>20	11-19	1-10	0	

* = ratio of study site to reference site x 100
** = ratio of reference site to study site x 100

The maximum score is 48. The score for each site is normalized to the reference (site score / reference score x 100) to determine degrees of impairment according to Table 2.

Table 2. Impairment Categories

>80	No Impairment
55-80	Slight Impairment
25-55	Moderate Impairment
<25	Severe Impairment

Reference Site

The aquatic community of a reference site is compared to that of each study site to determine how much impact has occurred. The reference site should be in the same "ecoregion" as the study sites and be approximately the same size. It should be as pristine as possible, representing the best conditions possible for that area.

A previous study of the aquatic community of the Eel River watershed [5] suggested that Twelve Mile Creek had one of the best fish communities and habitat values in the area. The site at CR 450 N has the highest aquatic habitat value of all other accessible sites on Twelve Mile Creek. Therefore, this site (Site 4) was used as the basis of comparison for all other sites in the watershed.

Habitat Analysis

Habitat analysis was conducted according to Ohio EPA methods [21]. In this technique, various characteristics of a stream and its watershed are assigned numeric values. All assigned values are added together to obtain a "Qualitative Habitat Evaluation Index." The highest value possible with this habitat assessment technique is 100.

Water Chemistry

Water chemistry measurements were made at each study site on the same day that macroinvertebrate samples were collected. Dissolved oxygen was measured by the membrane electrode method. The pH measurements were made with a Cole-Parmer pH probe. Conductivity was measured with a Hanna Instruments meter. Temperature was measured with a mercury thermometer. All instruments were calibrated in the field prior to measurements.

Macroinvertebrate Sample Collection

Samples in this study were collected by kicknet from riffle habitat where current speed was 20-30 cm/sec. Riffles were used because they were the most important benthic habitat present at all study sites. The kicknet was placed immediately downstream from the riffle while the sampler used a hand to dislodge all attached benthic organisms from rocks upstream from the net. The organisms

were swept by the current into the kicknet and subsequently transferred to a white pan. Each sample was examined in the field to assure that at least 100 organisms were collected at each site. All samples were preserved in the field with 70% ethanol.

Laboratory Analysis

In the laboratory, a 100 organism subsample was prepared from each site by evenly distributing the whole sample in a white, gridded pan. Grids were randomly selected and all organisms within grids were removed until 100 organisms had been selected from the entire sample.

Each animal was identified to the lowest practical taxon (usually genus or species). As each new taxon was identified. a representative specimen was preserved as a "voucher." All voucher specimens have been deposited in the Purdue University Department of Entomology collection.

Quality Assurance

To determine whether the biological monitoring technique was capable of producing reproducible results, a duplicate sample was collected during November at Site 2. The results are shown in the appendix. The biotic indices were within 10% of each other and both samples indicated "no impact." Therefore, the method was shown to be precise enough to make good, defendable decisions about water quality in this watershed.

RESULTS

Aquatic Habitat Analysis

When the Ohio EPA habitat scoring technique was used, the following aquatic habitat values were obtained for each site in the study:

	Score	% of Reference
Goose Creek (Site 1)	**51**	**64**
East Branch (Site 2)	**61**	**76**
West Branch (Site 3)	**57**	**71**
Reference Site (Site 4)	**80**	**100**
Lower Twelve Mile Creek (Site 5)	**79**	**98**

The maximum value obtainable by this scoring technique is 100, with higher values indicating better habitat. Sites with lower habitat values normally have lower biotic index values as well.

The scores indicate that the lowest habitat value in this study was at Site 1 (Goose Creek). Habitat at Site 1 was hampered by a paucity of stable bottom substrate and instream cover, by a very thin riparian buffer zone, and by moderate bank erosion. Sediment deposition appeared to be heavier at this site than elsewhere in the watershed. The three headwater sites (Sites 1,2, and 3) had lower habitat value than the two downstream sites. Photographs of all sites are shown in Fig. 3.

Fig. 3. Photographs of study sites

Site 1 - Goose Creek @ CR 925 E

Site 2 - East Branch @ CR 900E

Site 3 - West Branch @ CR 500 N

Site 4 - Twelve Mile Cr. @ CR 450 N

Site 5 - Twelve Mile Cr. @ CR 300 N

Table 3
Water Quality Measurements
November 8, 2005

	D.O. mg/l	pH SU	Cond. uS	Temp. (C)
Site 1 (Goose Creek) Time = 1:15 p.m.	9.4	7.8	710	13.3
Site 2 (East Branch) Time = 12:20 p.m.	9.7	7.8	750	12.3
Site 3 (West Branch) Time = 11:50 a.m.	8.1	7.5	640	12.8
Site 4 (Reference) Time = 11:15 a.m.	10.4	7.8	680	12.2
Site 5 (Lower 12 Mile) Time = 1:45 p.m.	11.8	7.9	680	12.6

Water Quality Measurements
April 28, 2006

	D.O. mg/l	pH SU	Cond. uS	Temp. (C)
Site 1 (Goose Creek) Time = 1:10 p.m.	15.0	7.8	640	13.7
Site 2 (East Branch) Time = 12:30 p.m.	12.6	7.6	650	13.4
Site 3 (West Branch) Time = 11:40 a.m.	12.8	7.6	580	13.3
Site 4 (Reference) Time = 11:15 a.m.	12.0	7.6	640	12.6
Site 5 (Lower 12 Mile) Time = 10:40 a.m.	11.3	7.5	610	12.3

D.O. = Dissolved Oxygen
Cond. = Conductivity
Temp. = Temperature in Degrees Centigrade

Table 4.
Data Analysis for 11/05 Samples

METRICS

	Site # 1	2	3	4	5
# of Genera	19	10	14	20	13
Biotic Index	4.4	5.0	5.3	5.2	5.0
Scrapers/Filterers	0.5	0.1	0.8	0.3	0.8
EPT/Chironomids	5.8	6.1	2.1	2.3	6.8
% Dominant Taxon	20	19	21	23	24
EPT Index	9	5	5	9	7
Community Loss Index	0.4	1.3	0.7	0.0	0.7
% Mayflies	26	8	2	16	28

SCORING

	Site # 1	2	3	4	5
# of Genera	6	2	4	6	4
Biotic Index	6	6	6	6	6
Scrapers/Filterers	6	6	6	6	6
EPT/Chironomids	6	6	6	6	6
% Dominant Taxon	6	6	6	6	6
EPT Index	6	4	6	6	6
Community Loss Index	6	4	4	6	4
% Mayflies	6	2	2	4	6
TOTAL	48	36	40	44	44
% of Reference	100	82	91	100	100
Impairment Category	N	N	N	N	N

N = NONE S = SLIGHT M = MODERATE

Table 5
Data Analysis for 4/06 Samples

METRICS

	Site # 1	2	3	4	5
# of Genera	10	15	19	19	18
Biotic Index	5.9	5.1	5.6	5.0	4.5
Scrapers/Filterers	0.8	0.3	0.3	0.5	0.9
EPT/Chironomids	0.3	1.3	0.9	1.1	2.7
% Dominant Taxon	25	20	23	23	39
EPT Index	1	7	8	7	10
Community Loss Index	1.1	0.4	0.3	0.0	0.3
% Mayflies	19	23	7	30	49

SCORING

	Site # 1	2	3	4	5
# of Genera	2	4	4	6	6
Biotic Index	4	6	6	6	6
Scrapers/Filterers	6	6	6	6	6
EPT/Chironomids	2	6	6	6	6
% Dominant Taxon	6	6	6	6	2
EPT Index	0	6	6	6	6
Community Loss Index	4	6	4	6	6
% Mayflies	4	4	2	6	6
TOTAL	28	44	40	48	44
% of Reference	58	92	91	100	92
Impairment Category	S	N	N	N	N

N = NONE S = SLIGHT M = MODERATE

DISCUSSION

Chemical parameters measured at each site indicate that dissolved oxygen (D.O.), pH, temperature, and conductivity fell within acceptable ranges for most forms of aquatic life.

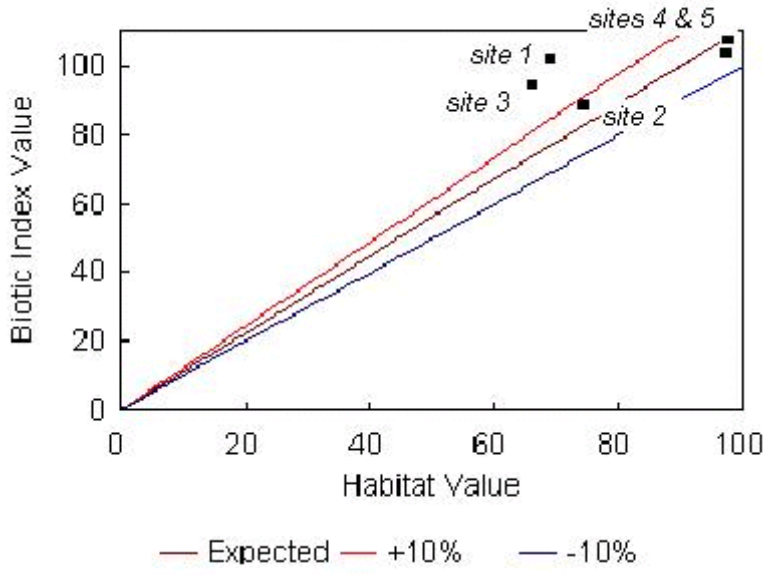
A total of 43 macroinvertebrate genera were collected at the five sites. The most commonly collected invertebrates during the autumn sampling period were net-spinning caddisfly larvae (*Ceratopsyche* and *Cheumatopsyche*), mayfly larvae *(Isonychia sayi*), and riffle beetles (*Stenelmis* and *Optioservus*). All of these dominant forms are known to be relatively intolerant to pollution. The spring samples were dominated by different forms, primarily the midges *Orthocladius obumbratus* and the mayfly *Baetis amplus*.

Tables 4 and 5 show how the aquatic communities at the four study sites compared to that of the reference site. All sites showed "no impact" during the autumn sampling period. Site 1 (Goose Creek) was slightly impacted during the spring sampling period.

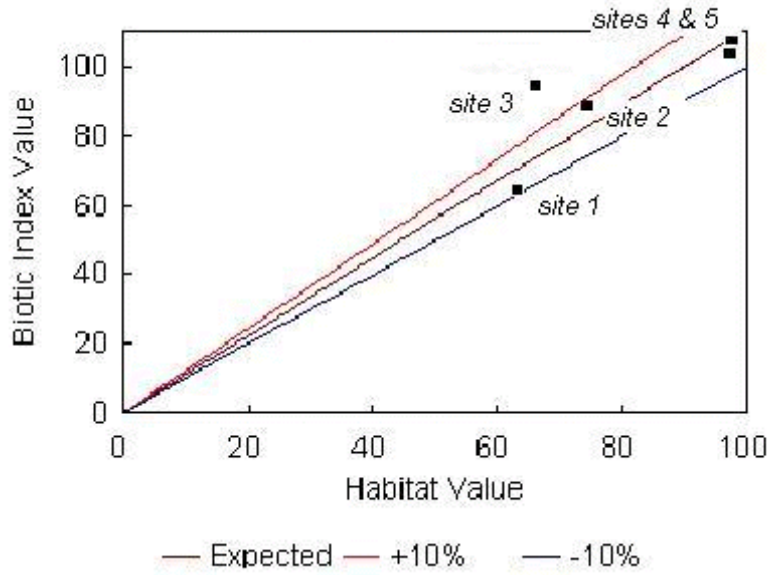
Figure 4 shows the normal relationship of biotic index scores to habitat values (a linear relationship according to [4]). The figure also shows a range of plus or minus 10% to account for a certain amount of measurement variability. When biotic index values fall below this range, the site typically has degraded water quality. Figure 4 indicates that all of the study sites had biotic values within or above the range expected from its measured habitat value. Therefore, biotic values are dependent more on habitat degradation than on water quality.

Figure 4.
Habitat vs. Biotic Index Scores

Sites falling outside the +10% range may be affected by degraded water quality



November 2005 samples



April 2006 samples

Comparison to Previous Studies

Aquatic habitat was evaluated at each of the five sites in 1998. The habitat values at most sites did not change more than 5% in the intervening years, except at site 2. Habitat at site 2 (The East Branch of Twelve Mile Creek) improved by about 20%, primarily due to the establishment of additional "cover" in the form of overhanging vegetation as the stream recovered from previous channelization.

The benthic macroinvertebrate community of Twelve Mile Creek was examined previously in October 1998. A comparison of the previous results with the present study is shown below:

	Fall 1998 Biotic Index Score	Impairment	Fall 2006 Biotic Index Score	Impairment
Site 1	58	Slight	100	None
Site 2	75	Slight	82	None
Site 3	`96	None	91	None
Site 4	100	None	100	None
Site 5	100	None	100	None

Previously, two of the five sites were slightly impaired during the fall sampling period. Now, none of them are impaired. Pollution-intolerant animals such as stoneflies, *Chimarra* caddisflies, and *Ephemerella* mayflies were not present at all in 1998 but were present and even abundant at some sites in 2005.

Site 1 (Goose Creek) showed the greatest improvements in biotic index scores between 1998 and 2006, especially in the autumn sample. A comparison of the autumn metrics from 1998 and 2006 is shown below:

	Autumn 1998	Autumn 2006	Trend
# of Genera	10	19	Improved
Biotic Index	6.0	4.4	Improved
Scrapers/Filt.	0.0	0.5	Improved
EPT/Chir	3.2	5.8	Improved
% Dominant	42	20	Improved
EPT Index	4	9	Improved
CLI Index	0.6	0.4	Improved
% Mayflies	13	26	Improved

Table 6 shows sediment-tolerance values for many of the commonly collected animals in these streams. The proportion of sediment and turbidity-tolerant forms was slightly higher at the study sites than at the reference site. This may indicate that excess sedimentation may be a minor problem, especially at Site 1 (Goose Creek), which had a community dominated by sediment-tolerant forms.

Table 6. Sediment-Tolerant Species Observed
(Literature references to the species as an indicator are shown in brackets)

Sediment-Tolerant Species		Sediment Intolerant Species	
Cheumatopsyche sp.	[10] [9]	Ceratopsyche sp.	[8]
Hydropsyche betteni	[9]	Chimarra obscura	[10]
		Limnephilidae	[10]
		Stenonema vicarium	[10] [15]
Stenacron interpunctatum	[10]	Ephemerella spp.	[10]
Orthocladius spp.	[10] [16]	Perlodidae	[10]
Thienemannymia group	[10]	Microtendipes caelum	[10]

% of Sediment-Tolerant Organisms at the Study Sites

	1998	2005	Trend
Site 1	62%	20%	decrease
Site 2	48%	30%	decrease
Site 3	57%	24%	decrease
Site 4	40%	38%	decrease
Site 5	45%	29%	decrease

% of Sediment-Intolerant Organisms at the Study Sites

	1998	2005	Trend
Site 1	9%	41%	increase
Site 2	14%	31%	increase
Site 3	10%	31%	increase
Site 4	13%	32%	increase
Site 5	18%	27%	increase

RECOMMENDATIONS

1. **Advertise the success of this program as widely as possible.**

2. **Discourage artificial channelization of these streams. Minimizing channelization allows the streams to retain a natural channel that enhances aquatic habitat and biotic index values.**

3. **Discourage direct access to the streams by livestock. Large numbers of livestock can trample stream banks, decreasing the ability of streamside vegetation to filter out pollutants and hastening erosion.**

4. **Continue to encourage volunteer monitoring in the watershed. Such programs provide invaluable educational opportunities and give participants a sense of ownership in the water quality improvements observed over the years.**

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Appendices

BIOASSESSMENT SUMMARY

Twelve Mile Creek - Cass County

Purpose

To measure the water quality of Twelve Mile Creek in Cass County, Indiana after implementation of "best management practices" in the watershed.
A bioassessment technique was used. Bioassessment uses knowledge of the biology of stream- dwelling animals to measure stream health.

Watershed Characteristics

The watershed is primarily agricultural.

Best Management Practices (BMPs)

BMPS to reduce sedimentation and nutrient inputs were initiated in 1998. The project was funded by IDNR's Lake and River Enhancement Program, at a cost of $260,000.

Results

Water quality has improved since 1998, especially in the Goose Creek tributary. The number of sediment-intolerant animals has greatly increased.

Recommendations

Make sure participating land owners know of the success of this program.

Watershed Gauge
A score of 100 is our goal

Date: 2005-2006

Study conducted by:

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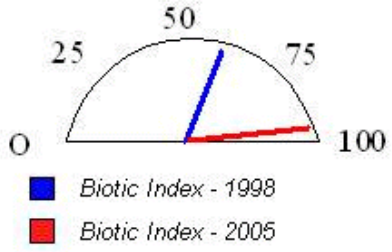

Best Management Practice Funding in the Watershed

PROJECT NUMBER	DIVERSION (each)	FENCING (feet)	FIELD WIND BREAK (acres)	FILTER STRIP (acres)	GRADE STABILIZATION STRUCTURE (each)	GRASSED WATER WAY (each)	LIVE STOCK WATERING FACILITY (each)	PASTURE & HAY PLANTING (acres)	RIPARIAN BUFFER (acres)	TREE PLANTING (acres)	Waste Management System	WASTE MANAGEMENT (each/gallons)	WASCOB (each)
209-99-2	1					1000							
209-99-3										5.0			
209-99-4	2	350				300		16.0					1
209-99-5		3000						9.1					
209-99-6					2	1500							
209-99-7													
209-99-8					2	700							
209-99-9				4.9									3
209-99-10			1.0										
209-99-11			0.2						2.0	1.0			
209-99-12			1.0										
209-99-13													
209-99-14													
209-99-15				5.4									
209-99-16				6.4									
209-99-17				6.3									
209-99-18		490						20.0					
209-99-19				2.4				19.0					
209-99-20				2.0	1	560							
209-99-21								29.2					
209-99-22													7
209-99-23		4500						38.0					
209-99-24													
209-99-25													
209-99-26			0.6	14.5	1	1080							
209-99-27					1								
209-99-28				14.2									
209-99-29				5.7									
209-99-30				6.5									
209-99-31													7
209-99-32							1						
209-99-33													13
209-99-34											1.0		
209-99-35												22000000	
209-99-36				1.5									
209-99-37				7.1									
209-99-38		3830					2	7.0					
209-99-40								21.9					
209-99-41													
209-99-42													
TOTALS	3.0	12170.0	2.8	76.9	7.0	5140.0	3.0	160.2	2.0	6.0	1.0	22000000	31.0

Habitat Scoring Results

	Site 1	Site 2	Site 3	Site 4	Site 5
SUBSTRATE	10	13	12	15	15
COVER	7	7	7	14	14
CHANNEL	11	16	14	18	17
RIPARIAN	6	6	7	9	9
POOL	7	8	7	11	11
RIFFLE	4	5	4	7	7
GRADIENT	6	6	6	6	6
TOTAL	51	61	57	80	79

QUALITY ASSURANCE DUPLICATE VALUES

Metric Values

Samples collected 11/8/05 at site 2 (East Branch of Twelve Mile Creek)

	Sample 1	Sample 2
Total Genera	10	15
EPT Genera	5	8
Scrapers/Filterers	0.1	0.3
% Dominant Taxon	19	22
EPT/Chironomids	6.1	5.1
Community Loss Index	1.3	0.6
Hilsenhoff Biotic Index	5.0	5.1
% Mayflies	8	14

Site Scores in Relation to the Reference (Site 4)

	Sample 1	Sample 2
Total Genera	2	4
EPT Genera	4	6
Scrapers/Filterers	6	6
% Dominant Taxon	6	6
EPT/Chironomids	6	6
Community Loss Index	4	4
Hilsenhoff Biotic Index	6	6
% Mayflies	2	4
	36	42

Mean Site Score = 39
Each duplicate is within 10% of the mean
Both scores indicate "no impact"

Record of Fish and Habitat
Twelve Mile Creek
@ CR 450 N
from Gammon & Gammon [5]

Habitat Parameter	Habitat Score
Substrate/Cover	18
Embeddedness	20
Water Velocity	15
Channel Alteration	14
Scouring/Deposition	14
Pool/Riffle Ratio	9
Bank Stability	6
Bank Vegetation	7
Bank Cover	6
TOTAL SCORE	108 (135 possible)

Calculated IBI score for Twelve Mile Creek = 44 (60 possible)

Individual fish species records not reported

COMMONWEALTH BIOMONITORING
Macroinvertebrate Identification Literature

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Rapid Bioassessment Results - Twelve Mile Creek - November 2005

	Site 1 Goose Cr	Site 2 E.Branch	Site 3 W.Branch	Site 4 12 Mile	Site 5 12 Mile
Chironomidae					
Orthocladius obumbratus	6	11		9	7
Cricotopus bicinctus				2	2
Brillia spp.	2				
Microtendipes caelum			10	2	
Polypedilum convictum	2			1	
P. fallax				1	
Chrionomus spp.			2		
Endochironomus spp.			6	2	
Thienemannimyia spp.	2		3	5	
Rheotanytarsus spp.					
Paratanytarus spp.				3	
Dicrotendipes spp.				1	
Tipulidae					
Antocha	2	12	1	7	1
Tipula		1	1		
Simuliidae		1			
Tabanidae	1		1		
Ephemeroptera					
Isonychia	15	8		6	13
Baetis flavistriga	2				1
Stenonema vicarium	3		2	7	3
Stenacron				1	
Ephemerella	6			2	11
Plecoptera: Perlodidae	3	2	1	5	6
Trichoptera					
Ceratopsyche bifida	7	17	16	13	13
C. sparna	2	12	5	1	5
Hydropsyche betteni	4	10	2		
Cheumatopsyche	8	19	18	23	9
Chimarra	20				
Polycentropis				2	
Limnephilidae				1	
Coleoptera					
Optioservus	11	7	21	3	24
Stenelmis	1		11	3	4
Psephenus	2				1
Odonata					
Boyeria					
Oligochaete		1			
Collembola	1				
Total	100	100	100	100	100

Rapid Bioassessment Results - Twelve Mile Creek - April 2006

	Site 1 Goose	Site 2 East Br	Site 3 West Br	Site 4 12 mile	Site 5 12 mile
Chironomidae					
Orthocladius obumbratus	25	11	23	21	12
Cricotopus bicinctus	13				1
C. trifascia		2	2	2	2
Cardiocladius			2		
Brillia spp.	13	20	4	8	7
Nanocladius spp.				2	
Microtendipes caelum	3				
Polypedilum convictum	13	4	15	6	2
Cryptochironomus fulvus				2	
Ablabesmyia mallochi		4	2	2	
Thienemannimyia spp.			4		
Tipulidae					
Antocha		4	1		1
Pseudolimnophilia			1	3	
Simuliidae	8				2
Ephemeroptera					
Isonychia		7		4	1
Baetis flavistriga			2		1
B. amplus	7	9	1	23	39
B. hageni	12		2	1	1
Stenonema vicarium		6		2	4
Ephemerella		1			3
Baetisca			1		
Caenis			1		
Trichoptera					
Ceratopsyche bifida		2		1	5
C. slossonae		6	3	1	
C. sparna		3			1
Hydropsyche betteni		6	2	2	2
Cheumatopsyche		12	25	10	3
Chimarra				1	1
Anabolia spp.			1		
Plecoptera					
Amphinemura					1
Acroneuria			2	2	3
Coleoptera					
Optioservus	1		1	1	6
Stenelmis	5	2	5	5	2
Psephenus herricki		1		1	
Total	100	100	100	100	100